

Claims

- [c1] 1.Apparatus for use in a motor vehicle, comprising:
a first steering link having a first socket at an end thereof;
a second steering link having a second socket at an end thereof;
a wheel having a rim defining a generally cylindrical inner wheel volume;
a steering knuckle having a spindle for supporting the wheel for rotation about a wheel axis of rotation and a steering arm having a through hole; and
a stud passing through the through hole in the steering arm and defining a link attachment axis located within the inner wheel volume, the stud comprising a first ball portion disposed at a first end of the stud above the steering knuckle and received in said first socket for pivotal movement of said first link relative to said first ball portion, and a second ball portion disposed at an opposite second end of the stud below the steering knuckle and received in said second socket for pivotal movement of said second link relative to said second ball portion, the stud and attached first and second sockets forming a ball joint unit located substantially within the inner wheel volume.
- [c2] 2.Apparatus according to claim 1 wherein the steering extends forwardly from the wheel axis of rotation.
- [c3] 3.Apparatus according to claim 1 wherein the steering knuckle is attached to a drive axle.
- [c4] 4.Apparatus according to claim 1 wherein one the first and steering link is a drag link, and the second steering link is a tie rod.
- [c5] 5.The apparatus according to claim 1 wherein the stud further comprises a first conical shank portion tapering smaller in diameter as it extends from the first ball joint and a second conical shank portion tapering smaller in diameter as it extends from the second ball joint, and the through hole comprises a first tapered portion engaging the first conical shank portion and a second tapered portion engaging the second conical shank portion.
- [c6] 6.The apparatus according to claim 1 wherein the stud comprises a first stud part and a second stud part;

said first stud part comprising the first ball portion and a shank portion projecting from said first ball portion;
said second stud part comprising the second ball portion and having a through opening extending axially through said second stud part; and
said shank portion of said first stud part extending through said through hole in said steering arm and through said through opening in said second stud part.

[c7] 7.The apparatus according to claim 1 wherein the stud comprises a first stud part and a second stud part;
said first stud part comprising the first ball portion and a shank portion projecting from said first ball portion, the shank portion having a male threaded end distal from the first ball portion;
said second stud part comprising the second ball portion and having a female threaded hole; and
said shank portion of said first stud part extending through said through hole in said steering arm and said male threaded end engaging said female threaded hole in said second stud part to secure said first stud part to said second stud part.

[c8] 8.The apparatus according to claim 1 wherein the stud comprises a first stud part and a second stud part;
said first stud part comprising the first ball portion and a shank portion projecting from said first ball portion, the shank portion having a female threaded hole in an end distal from the first ball portion;
said second stud part comprising the second ball portion and having a through opening extending axially through said second stud part; and
said shank portion of said first stud part extending through said through hole in said steering arm and into said through opening in said second stud part from a first end thereof, a male threaded fastener being inserted into said through opening from a second end thereof and threadingly engaging said female threaded hole in said shank portion of said first stud part to secure said first stud part to said second stud part.

[c9] 9.A ball joint unit for use in a motor vehicle steering linkage, comprising:

a first steering link having a first socket at an end thereof;
a second steering link having a second socket at an end thereof;
a steering knuckle for supporting a wheel and having a generally vertical through hole; and
a stud passing through the through hole in the steering knuckle and comprising a first ball portion disposed at a first end of the stud above the steering knuckle and received in said first socket for pivotal movement of said first link relative to said first ball portion, and a second ball portion disposed at an opposite second end of the stud below the steering knuckle and received in said second socket for pivotal movement of said second link relative to said second ball portion.

[c10] 10.The apparatus according to claim 9 wherein the stud further comprises a first conical shank portion tapering smaller in diameter as it extends from the first ball joint and a second conical shank portion tapering smaller in diameter as it extends from the second ball joint, and the through hole comprises a first tapered portion engaging the first conical shank portion and a second tapered portion engaging the second conical shank portion.

[c11] 11.The ball joint unit according to claim 9 wherein the stud comprises a first stud part and a second stud part;
said first stud part comprising the first ball portion and a shank portion projecting from said first ball portion;
said second stud part comprising the second ball portion and having a through opening extending axially through said second stud part; and
said shank portion of said first stud part extending through said through hole in said steering knuckle and through said through opening in said second stud part.

[c12] 12.The ball joint unit according to claim 9 wherein the stud comprises a first stud part and a second stud part;
said first stud part comprising the first ball portion and a shank portion projecting from said first ball portion, the shank portion having a male threaded end distal from the first ball portion;

said second stud part comprising the second ball portion and having a female threaded hole; and

said shank portion of said first stud part extending through said through hole in said steering knuckle and said male threaded end engaging said female threaded hole in said second stud part to secure said first stud part to said second stud part.

- [c13] 13.The ball joint unit according to claim 9 wherein the stud comprises a first stud part and a second stud part;
- said first stud part comprising the first ball portion and a shank portion projecting from said first ball portion, the shank portion having a female threaded hole in an end distal from the first ball portion;
- said second stud part comprising the second ball portion and having a through opening extending axially through said second stud part; and
- said shank portion of said first stud part extending through said through hole in said steering knuckle and into said through opening in said second stud part from a first end thereof, a male threaded fastener being inserted into said through opening from a second end thereof and threadingly engaging said female threaded hole in said shank portion of said first stud part to secure said first stud part to said second stud part.

- [c14] 14.Apparatus for use in a motor vehicle, comprising:
- a first steering link having a first socket fixed for movement with said first link;
- a second steering link having a second socket fixed for movement with said second link;
- a steering knuckle having a through hole; and
- a stud comprising a first stud part and a second stud part;
- said first stud part comprising a first ball portion received in said first socket to connect said first stud part for pivotal movement relative to said first link and a shank portion projecting from said first ball portion;
- said second stud part having a second ball portion received in said second socket to connect said second stud part for pivotal movement relative to said second link;
- said second stud part having a through opening extending axially through said

second stud part; and
said shank portion of said first stud part extending through said through hole in
said steering knuckle and through said axially extending through opening in
said second stud part.

[c15]